Chapter 5
Wetlands

NEW HAMPSHIRE DEPARTMENT OF
Environmental Services

Overview

New Hampshire's tidal and nontidal wetlands are of great importance for flood control, water filtration, water storage and recharge for both groundwater and surface water. These functions become more valuable with the expected increase in occurrence and severity of storm events associated with climate change (see Chapter 1 – Introduction and Overview). Wetlands also support the food chain, providing food and shelter for a variety of aquatic and upland plants and animals. Although New Hampshire has lost fewer wetlands to filling and dredging than many coastal states, landscape change poses a significant challenge to the protection of New Hampshire's wetlands.

5.1 Occurrence and Significance

5.1.1 Wetlands Occurrence

New Hampshire wetlands share three characteristics: 1) standing water or water at or near the ground surface during some portion of the growing season; 2) soils with characteristics that show they are saturated some of the time; and 3) plants adapted to growing in saturated soils. There is tremendous diversity in the types of wetlands found in the state. Tidal marshes and mud flats, freshwater red maple swamps, bogs, vernal pools, Atlantic white cedar swamps and wet meadows are all wetland types found in New Hampshire (Figure 5-1).

New Hampshire's glacial history is responsible for the occurrence of most of its wetlands. Glaciers carved out basins in rock and sediments, creating depressions and depositing fine material that restricts the drainage of water. The buildup of organic and fine sediments over time created various types of wetlands. Wetlands also form at the edges of rivers, lakes and streams where sediments and organic materials deposit to create shallows with abundant plant growth.

The estimated acreage of wetlands in New Hampshire ranges between 290,000 acres, estimated from the National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS), and 576,386 acres, estimated from soil surveys by the Natural Resource Conservation Service (NRCS) of the U.S. Department of Agriculture (Tiner, 2007). Accordingly, wetlands occupy between 5 percent and 10 percent of New Hampshire's landscape. An analysis of aerial photography by the New Hampshire Department of Environmental Services indicates that there are approximately 7,500 acres of tidal wetlands, with the vast majority of New Hampshire's wetlands being nontidal. (NHDES, 2002).

According to a study done in 1990 of wetland losses in the United States, New Hampshire had lost 9 percent of freshwater wetlands statewide (Dahl,1990). A more recent 2004 analysis suggests that about 10 percent of nontidal wetlands have been filled or drained for roads, residential development and industrial development (NHDES, 2004). Further, about one-quarter of the state's tidal wetlands have been lost, and conversion of tidal wetlands to freshwater wetlands by tidal restriction appears to be a major concern (Odell et al; 2006). In addition to direct losses, the quality of

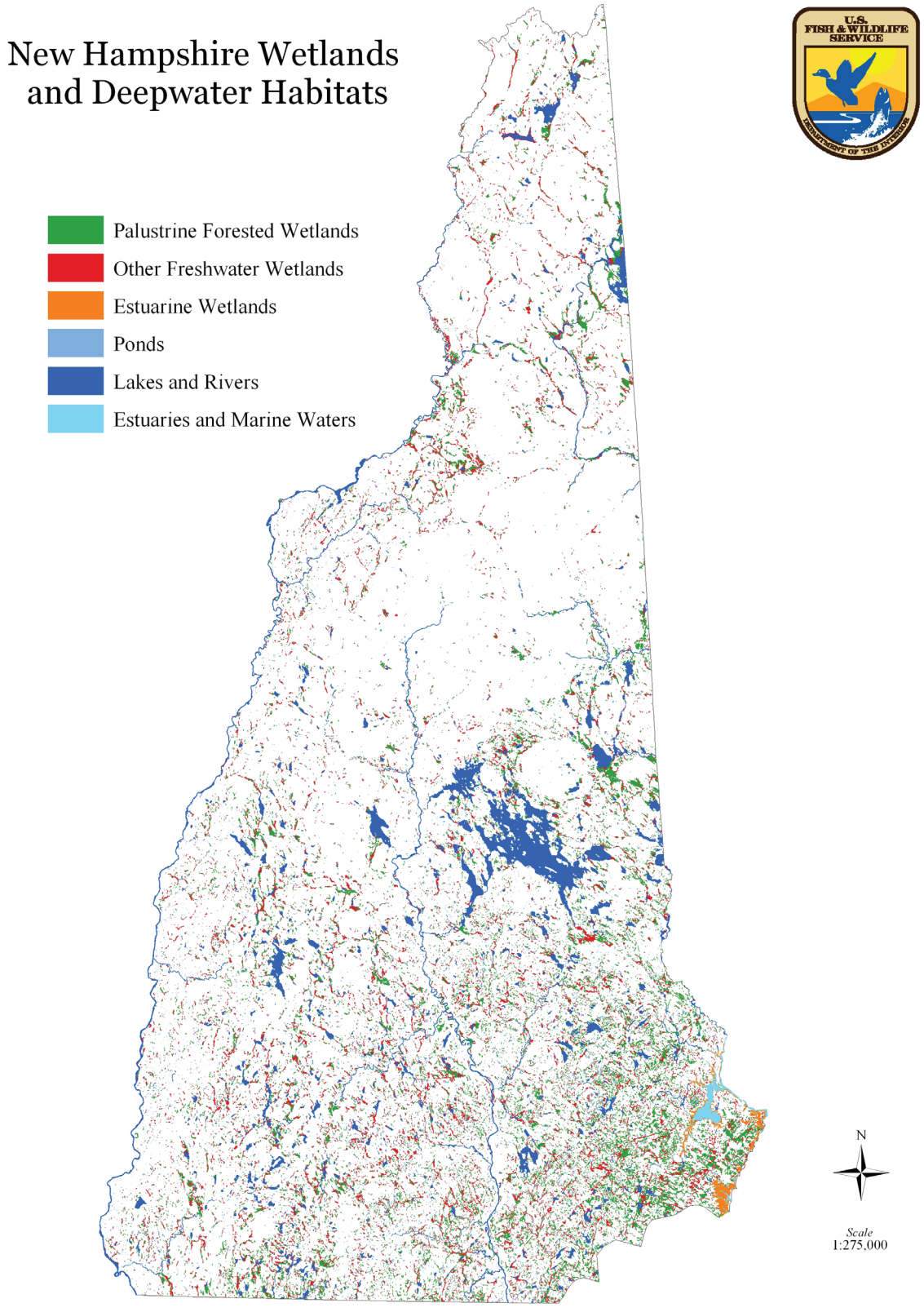

Figure 5-1. New Hampshire wetlands and deepwater habitats mapped by the National Wetlands Inventory. *Source: Tiner, 2007.*

wetlands can be significantly affected by land use change in upland areas. No quantification of these impacts is available.

5.1.2 Wetlands Significance

Wetlands are an important component of the hydrologic cycle described in Chapter 1 – Introduction and Overview. Although not all wetlands are created equal and the functions and values of wetlands vary significantly, there are some key values attributed to wetlands including flood control, water purification, water storage and recharge to both surface and ground waters, and ecosystem protection. These values, as well as the economic value of wetlands, are outlined in Figure 5-2 and discussed below:

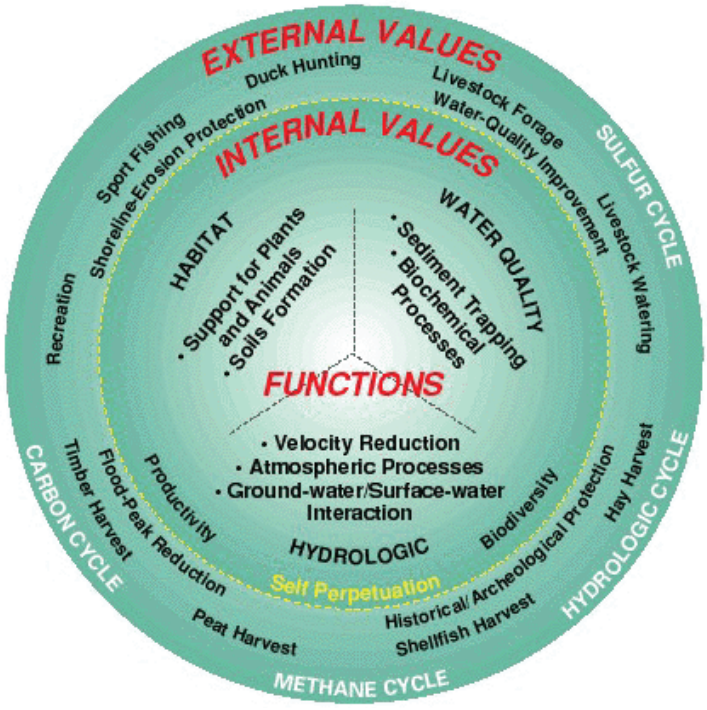

Figure 5-2. Values and functions of wetlands.
Source: Novitski et al., 1997.

Flood Control

A floodplain is flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding (Figure 5-3). It includes the floodway, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. Floodplains perform important natural functions, including temporary storage of floodwaters, moderation of peak flows, maintenance of water quality, groundwater recharge, and prevention of erosion. Seasonal flooding also maintains biological and physical diversity. The ability to reduce the peak level of floods and delay the flood crest is one of the most widely recognized functions of inland wetlands (Carter et al., 1979; Novitzki, 1979; Tiner, 1984). This function is accomplished chiefly through storage of surface water in wetland basins after snowmelt and major precipitation events, and the reduction in flood flow velocities as water passes through wetland vegetation and over the soil surface. According to the Environmental Protection Agency, an acre of wetland can store 1 million to 1.5 million gallons of floodwater (National Association of Counties [NACO], 2006). This value is of increasing importance given the impacts of landscape change and climate change described in Chapter 1 – Introduction and Overview.

Water Filtration

Many types of wetlands retain, remove, and transform nutrients and contaminants, thus improving the quality of surface water (Golet et al., 1993). Dense wetland vegetation provides friction, slowing down stream and river flows causing sediments to settle out of the water. The EPA notes

that as much as 80 percent to 90 percent of sediments in the water column may be removed as they move through wetlands (Madison & Paly, 1994). While excess sediment itself can cause environmental degradation, the reduction of sediment also results in a reduction of sediment-bound pollutants and nutrients, such as heavy metals and phosphorus. Wetland plants also take up nitrogen and phosphorus, decreasing the likelihood of water quality problems downstream. Wetlands host a diverse community of microorganisms that further natural water treatment by transforming nutrients, such as nitrogen and even toxic substances, into less problematic forms. The increased pollutant loadings associated with landscape change and stormwater runoff described in Chapter 1 – Introduction and Overview and Chapter 10 – Stormwater make this function of wetlands particularly important.

Figure 5-3. Floodplain forest along the Merrimack River in Concord. *Source: NHDES Wetlands Bureau.*

Water Storage and Recharge to Surface Water and Groundwater

As described previously, many wetlands can store a tremendous amount of water. Water moves slowly through wetland soils and vegetation and provides gradual, purified recharge to connected surface waters and groundwater. This function is of particular importance in times of drought as it maintains stream flows and groundwater levels when precipitation is below normal.

Figure 5-4. Example of a vernal pool. *Source: NHDES Wetlands Bureau.*

Wildlife Habitat and Aquatic Nurseries

Wetlands are essential for a wide variety of plants and animals. They provide birds, mammals, reptiles, amphibians, fish, insects and plants with food, water and shelter, including animal breeding or nesting habitat. Approximately 66 percent of New Hampshire's species of greatest conservation concern are wetland- or surface water-dependent (NHF&G, 2006). More specifically, the state has 34 rare wetland-dependent species, e.g., bald eagle, Atlantic sturgeon, including 24 animals and 10 plants (Clean Water Network

[CWN], 2002). These and other wetland-dependent species need both wetlands and natural upland areas to survive. Many species that inhabit uplands for most of the year depend on wetlands for seasonal breeding habitat. In particular, many amphibian species depend on seasonally flooded vernal pools to provide essential breeding areas but live in upland areas the remainder of the year (Figure 5-4). Additionally, some species that spend their entire lives in upland areas depend on a food source that is wetland-dependent. Hognose snakes, for example, primarily eat toads that require wetlands for their early development.

Wetlands are of particular importance for New Hampshire's fish and shellfish populations. As previously noted, wetlands help maintain consistent stream flows during floods and droughts. By helping to moderate or sustain stream flows, wetlands help prevent habitat degradation and the associated invasion of exotic species. According to USFWS, all wetlands that maintain stream flow should be considered vital to sustaining a watershed's ability to provide in-stream fish and shellfish habitat, regardless of whether those wetlands provide significant habitat themselves (Tiner, 2003). Wetlands also directly provide spawning and nursery habitat for commercially important fish and shellfish. Shellfish beds especially depend on the role of tidal wetlands in reducing fine sediment and silt deposits.

Figure 5-5. Tidal wetland with Pickleplant (*Salicornia*). *Source: NHDES Wetlands Bureau.*

Economic Importance

Given the important functions and values of wetlands described above, there have been a number of attempts to place an economic value on wetland resources. For instance, a 2006 EPA funded study estimated that the economic benefits generated by a single acre of wetland amount to $150,000 to $200,000 (NACO, 2006). The same study found that wetlands increase surrounding real estate values by an estimated 28 percent while also enhancing the quality of life. In 2002 a study by the Clean Water Network estimated the economic value of New Hampshire's remaining wetlands to be approximately $1.2 billion (CWN, 2002).

5.2 Issues

5.2.1 Wetlands Are Threatened by Landscape Change, Fragmentation and Indirect Impacts

New Hampshire is the fastest growing New England state with approximately 260,000 (20 percent) more people expected to move to the state between 2005 and 2030 (New Hampshire Office of Energy and Planning, 2006). To accommodate this growth, most of which is anticipated to occur in the southeast third of the state, more lands abutting and containing wetlands are now being developed. As a result there is increased fragmentation of wetlands for roads and driveways and there is increasing concern for the indirect impact that upland development has on the quality of wetlands. Groundwater withdrawals associated with development are also a concern.

Fragmentation of wetlands interferes with wetland values previously described, particularly wildlife habitat (Figure 5-6). Fragmentation results in some loss of the wetland itself and disrupts migratory and breeding patterns of many wetland-dependent species.

Indirect impacts to wetlands from upland development include increased loads of sediments, nutrients, chlorides (road salt), and other pollutants carried by stormwater. As noted above, excessive sedimentation can interfere with a wetland's water storage and flood control values. Wetlands generally show sharp declines in the diversity of native plant species and animal communities when adjacent uplands are developed (Wright et al., 2006). The development of adjacent uplands is also a concern because many wildlife species need both wetlands and uplands for survival. Unless a wetland is designated a "prime wetland," is contiguous to a lake, river or stream protected by the Comprehensive Shoreland Protection Act (RSA 483-B), or is a tidal wetland, there are no state regulations that specifically provide for wetland buffers. For more information about the importance of upland buffers for wetlands see "Buffers for Wetlands and Surface Waters: A Guide for Municipalities" (Chase et al., 1995).

Figure 5-6. Example of fragmentation of tidal wetlands at Seabrook Harbor. *Source: U.S. Army Corps of Engineers New England District, 2008.*

Floodplains typically extend beyond the regulatory authority of state permitting agencies because many floodplains are not wetlands. Floodplain development can significantly affect the quality and hydrology of adjacent wetlands by diverting floodwater and increasing runoff and stormwater discharges to them. Finally, draining of wetlands through excavation or pumping of groundwater can also degrade wetlands.

5.2.2 State Wetland Permitting Load Strains DES's Ability to Provide Effective Protection and Customer Service

New Hampshire was one of the first states to regulate the protection of wetlands. Jurisdiction began for tidal wetlands in 1967 and for nontidal wetlands in 1969. Since then, the Legislature has consistently recognized the importance of this resource. New Hampshire's wetlands are protected through a permitting process that is outlined in Section 5.3.1 of this chapter.

As more people move to New Hampshire and development pressures continue, there is less land available that does not require a wetland permit to develop. Consequently, there has been a steady increase in the resources required to effectively protect wetlands. At the same time, there is concern that the wetland permitting process is inefficient, unduly burdensome and inconsistent. DES is working with stakeholders to determine how limited resources can be used most effectively to protect this important resource and improve stakeholder satisfaction.

In addition, compliance with permits is not assessed in a systematic manner; rather it is primarily based on complaints received from the public. Backlogs often exist both in permitting and compliance. The issues with the current wetland regulatory process fall broadly into the following categories: consistency, timeframes, customer service, compliance and tracking. There is also stakeholder concern that the current permitting process is not well integrated with other land use permitting and may not result in the greatest environmental benefit.

5.3 Current Management and Protection

The wetlands described and discussed in this chapter are primarily protected by state regulations with state funding. Municipalities and the federal government also have significant roles in protecting New Hampshire's wetlands. Management and protection at each level of government is described below.

5.3.1 State Management and Protection

The primary state law that authorizes the permitting program to protect wetlands is RSA 482-A, the New Hampshire Fill and Dredge in Wetlands Act (the "Wetlands Act"). The Wetlands Act is administered by DES and it applies to all wetlands, no matter how small the impact. The Wetlands Act and the rules it authorizes have evolved over time and provide for three key components of wetland protection: permitting, mitigation, and prime wetland designation. Each of the three components is described below. Other significant state laws and programs are also identified.

The premise of wetland regulation in New Hampshire is that any destruction of wetlands should be avoided or minimized. As in most states, New Hampshire's wetland laws address direct impacts such as dredging or filling wetlands. Except in the cases of prime wetlands, wetlands adjacent to protected shorelands, and tidal wetlands where protective buffers are required, New Hampshire does not specifically regulate the indirect impact to a wetlands function or value from

upland development. In certain instances, generally for large developments and projects, federal involvement under the Clean Water Act requires that indirect impacts be addressed (see Federal Management and Protection Section below).

Wetland Permits

The state's wetland permitting program is the primary means of wetlands regulation in New Hampshire. In addition to permits issued for impacts to wetlands, the DES wetlands program also issues permits for docks and stream crossings. Each of the 2,000+ applications or notifications received annually for alteration of wetlands, surface water, or other jurisdictional areas are reviewed to ensure that wetland dredge or fill impacts are minimized or avoided. Each proposed project is classified according to its potential environmental impact as a minimum, minor, or major impact. The documentation required to obtain a permit is related to the impact classification, with minor and major impact projects possibly requiring mitigation and significantly more technical information and assessment than minimum impact projects. Federal involvement in permitting decisions is discussed below, and is limited to larger projects or to those that impact significant resources. Most wetland applications are screened for impacts to threatened and endangered wildlife, plants, and plant communities, and are reviewed by New Hampshire Fish and Game Department for input on issues related to habitat protection and endangered species and by New Hampshire Department of Resources and Economic Development for issues related to threatened and endangered plant species and plant communities. Permitting decisions made by DES can be appealed to the Wetlands Council, established under the Wetlands Act.

Wetlands Mitigation

For projects with significant wetland impacts, based on either square footage (> 10,000 square feet) or the impact on sensitive species, DES requires the applicant to compensate for the unavoidable loss of wetland functions and values that will result from the proposed dredge or fill. The applicant must have also demonstrated that the project is the least impacting alternative. The applicant may provide compensation, or "compensatory mitigation," through one or more of the following four options.

- Wetland construction in upland areas. This option is seldom selected because construction of new wetlands is complex and expensive.
- Wetland restoration that re-establishes a filled, dredged or drained wetland to its historic condition. Wetlands created by removing fill and restoring hydrology produce more successful habitats than wetland construction. This option is the most viable when the water available historically to feed the wetland is available for restoration.
- Conservation easements that place bordering upland and wetland areas in permanent protection from development to protect function and value of remaining wetlands.

Applicants must document that the above three options are not available before considering the fourth mitigation option.

- The Aquatic Resource Mitigation Fund (ARM Fund), established in 2006, involves payment into one of 16 watershed-based funds in lieu of the other three options. These payments are pooled together to fund projects within the same watershed (Figure 5-7). The ARM Fund seeks no net loss of aquatic resource functions and values using a watershed

approach. The DES regulations allow for the funds in each watershed account to accumulate for two years after the first deposit into a specific account. After two years have lapsed, the funds will be advertised to fund restoration projects to permanently protect high-value wetlands in the respective watershed. The ARM Fund provides a means for mitigation of project impacts where a conservation easement holder may not be available and wetlands creation or restoration is not feasible. As of October 2008, 17 projects had made payments into the ARM Fund.

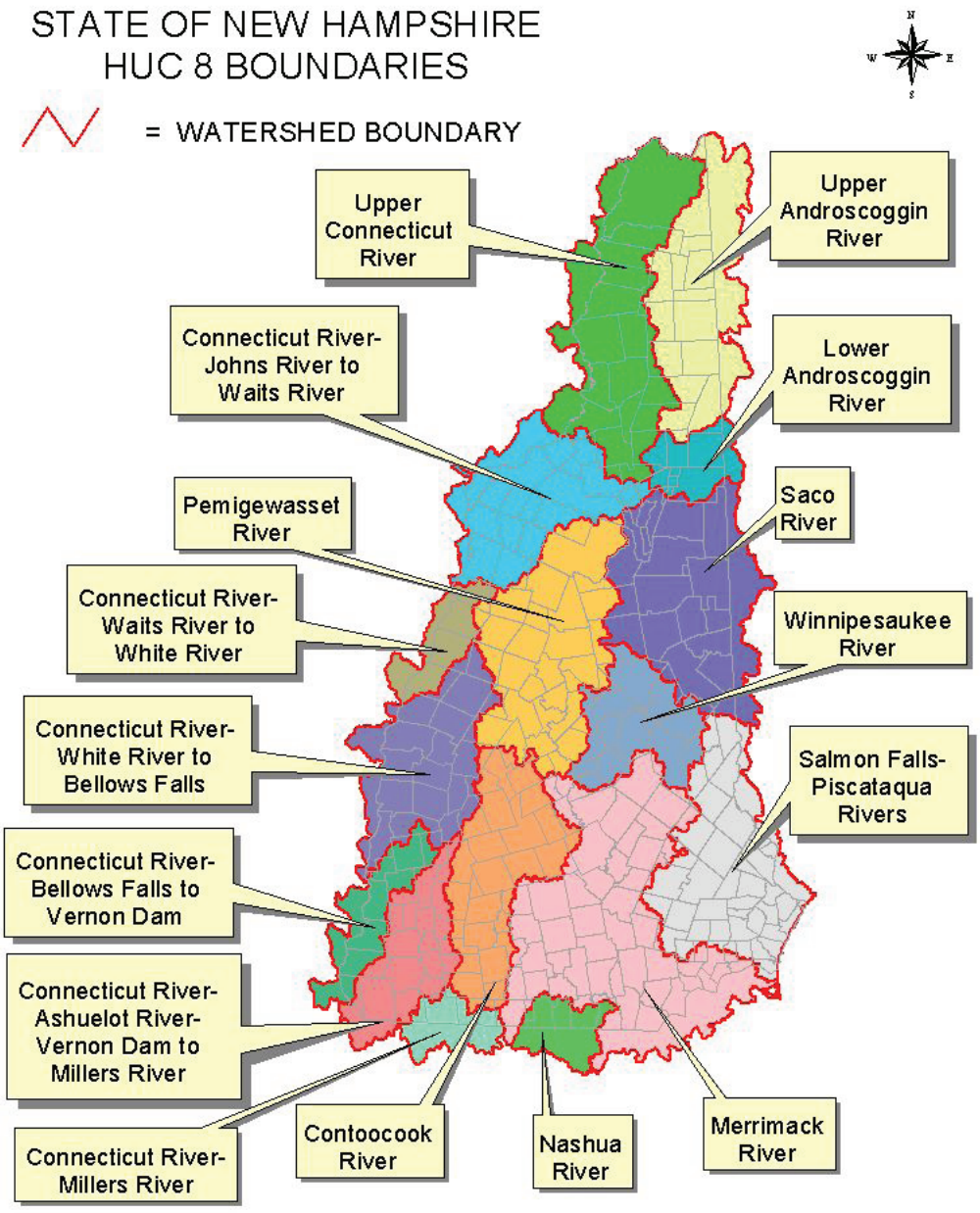

Figure 5-7. New Hampshire's 16 watershed-based fund areas.

With the lack of available restoration sites and limited success of wetland construction, the use of conservation easements has been the most common type of mitigation for projects with significant wetland impacts. Figure 5-8 shows the total permitted acreage of wetland impacts for the period 2001 – 2007, along with the total acreage for each type of mitigation required for larger projects.

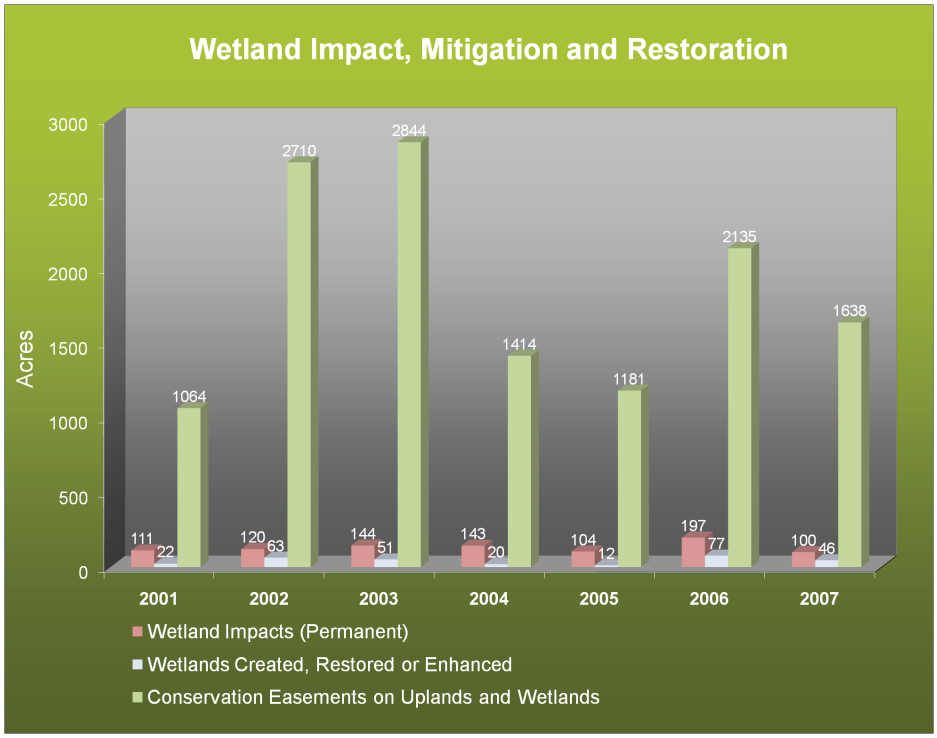

Figure 5-8. Total permitted acreage of wetland impacts and mitigation type for the period 2001 – 2007. *Source: NHDES, 2008.*

Prime Wetlands Designation

In 1979 New Hampshire's wetlands law was amended to provide an option for municipalities to designate high value wetlands for greater protection. Wetlands are evaluated for designation using the "New Hampshire Method" as detailed in two manuals, one for nontidal wetlands and the other for tidal wetlands (Ammann & Stone, 1991; Cook et al., 1993). The designation of these wetlands must then be adopted by the municipality by vote of the residents after undertaking a process comparable to the adoption of zoning ordinances. The mapping and a report of the evaluation of the wetland(s) is submitted to DES for acceptance. Once DES formally accepts the designation, the designated prime wetland and a 100 foot buffer around it are afforded special protection by DES under the wetlands law.

Projects involving impacts to prime wetlands or the prime wetland buffer are classified as major impact projects, requiring a more stringent burden of proof that the project is the least impacting alternative and that the proposed activity, either alone or in conjunction with other human activity, will not result in the significant net loss of any of the values identified by law. As of November 2008, 26 municipalities have designated prime wetlands to take advantage of the additional protections. Over the years some municipalities have designated wetlands in addition to those initially designated as prime.

Other State Regulations

Comprehensive Shoreland Protection Act – This law establishes 250 feet of protected area for lakes, large rivers and large ponds. It is administered by the DES Wetlands Bureau. Because of the co-occurrence of these surface waters with wetlands, the act also serves to protect wetlands from indirect impacts. This program is described in section 10.3.4 of Chapter 10 – Stormwater.

Alteration of Terrain – This law requires a permit for any project that disturbs 100,000 square feet of land or 50,000 square feet of protected shoreland. The permit is intended to limit the negative impacts associated with increased stormwater runoff at developed sites. To the extent that projects requiring these permits are adjacent to wetlands, this law protects wetlands from indirect impacts caused by stormwater. This program is described in section 10.3.3 of Chapter 10 – Stormwater.

Rivers Management and Protection Program – For rivers that have been designated by the Legislature for protection under this program, local advisory committees routinely comment on development projects. Again, because of co-occurrence of rivers and wetlands, this also serves to protect wetlands, although not through any specific regulatory or permitting authority. This program is described in section 2.3.3 of Chapter 2 – Rivers.

Large Groundwater Withdrawal Permitting Program – This program is administered by DES and serves to prevent impacts to wetlands and other water resources from large withdrawals of groundwater from wells sited after July 1998. This program is described in section 4.3.2 of Chapter 4 – Groundwater.

401 Water Quality Certification – Section 401 of the federal Clean Water Act requires state certification that a federal permit for a proposed activity will not violate state water quality standards. A 401 certificate is usually only necessary for wetlands when the U.S. Army Corps of Engineers decides to issue an individual 404 permit in conjunction with a state wetlands permit. In these cases there can be more consideration of indirect impacts to wetlands caused by development of upland portions of the project.

5.3.2 Federal Management and Protection

Federal Clean Water Act

The U.S. Army Corps of Engineers is the lead agency under Section 404 of the federal Clean Water Act responsible for wetland protection. The Corps has issued a general permit in New Hampshire that allows the state to regulate direct impacts to wetlands via the state permitting program previously described (U.S. Army Corps of Engineers New England District, 2007). The Corps, however, retains the right to issue an individual 404 permit. This is generally done when a project involves particularly significant impacts. The EPA is involved with all individual 404 permits through oversight of the issuance of Section 401 water quality certifications by DES described above. The EPA may also determine that any state permit requires a 401 water quality certification, regardless of Corps involvement, although this is not typically done. Federal involvement in the wetland permitting process allows for far greater consideration of indirect impacts than state permitting authorized by the New Hampshire Wetlands Act.

Endangered Species Act

As noted above, New Hampshire's Fish and Game Department and the Department of Resources and Economic Development's Natural Heritage Bureau review wetlands permit applications to comment on compliance with the federal Endangered Species Act, in addition to the parallel state Endangered Species Conservation Act and Native Plant Protection Act.

5.3.3 Local and Regional Protection

In addition to the key role described above that municipalities play in designating prime wetlands, they are also integrated into the state permitting process in an advisory role through conservation commissions, established under RSA 36-A. State wetlands law provides for consideration of conservation commission comments for wetland permits and notifications. As described in Chapter 1 – Introduction and Overview, local land use regulation is key to water quality protection. Many communities have gone beyond state regulation by establishing local requirements to protect wetlands, such as the establishment of setbacks or buffers. In addition, municipalities and regional planning agencies have played a key role in conducting inventories of wetland resources.

5.4 Stakeholder Recommendations

This section contains key recommendations that have been developed in concert with a group of volunteer stakeholders who have reviewed and contributed to this chapter. For this particular chapter, the first recommendation also reflects the work done under a DES initiative to engage stakeholders to identify changes to the current wetlands permitting process in order to improve environmental results and increase stakeholder satisfaction.

5.4.1 Improve Wetland Permitting to Increase Efficacy and Stakeholder Satisfaction

Make Wetlands Regulation Simpler and More Consistent

In 1969 New Hampshire became one of the first states to create comprehensive wetland regulations. These regulations have been revised and expanded over time to reflect advances in wetland science and to address the realities of New Hampshire's economic growth. Like an old New England farmhouse that has been expanded piece-meal over the years as needs arose and resources allowed, the current structure of the rules no longer has a very coherent form. Further, the plain meaning of some rules has been "adjusted" by various policy pronouncements over the years, and the not-so-plain meaning of other rules has been subjected to changing interpretations. For many practitioners, applicants, and conservation-minded citizens, the wetlands rules are confusing and difficult to interpret and need to be rewritten. DES has committed to rewriting these rules in the near term. In addition, although DES's wetlands program has many documents such as applications, fact sheets, and guidelines for wetlands permitting, the program does not have a comprehensive set of standard operating procedures. Such a document would improve consistency and make the permitting process far more transparent.

Integrate Wetlands Regulation with Other Regulatory Processes

The environment is an integrated system, but land use permitting is not. A new development typically needs permits for wetlands, alteration of terrain, on-site disposal systems, and possibly shoreland protection and water supply. Each of these currently requires a separate permit through a separate DES program. DES should look at the various environmental aspects of a project and co-

ordinate permitting so as to achieve the best environmental outcome. This would require changes in staff responsibilities and expertise, improved data management capabilities and even changes in legislation.

The Level of Wetland Regulation Should Correspond to the Level of Impact

Consideration should be given to dedicating more state resources to permitting projects in undeveloped settings with greater impacts and less resources to smaller impact projects in already highly developed settings. DES should work with stakeholders to investigate the use of permit-by-rule or general permits and third party verification. The goal would be to achieve the same level of compliance while focusing DES's technical expertise on reviewing those projects which pose the greatest threats to wetlands, especially those with complex designs, restoration activities, and potential indirect impacts.

Wetlands Need to Be Protected from Indirect and Cumulative Impacts

Many people now understand that the biggest threat to wetland values is not through destruction by direct filling or dredging but through impacts from adjacent activities. The quality of wetlands is strongly influenced by the quality of the adjacent uplands. The issues related to urban and suburban runoff to wetlands, wetland-dependent wildlife species, groundwater recharge, and flooding all point to the upland areas around wetlands as being critical to the ecological functions of those wetlands. There are three suggestions for better addressing this issue of indirect and cumulative impacts.

First, there is a need for a common set of methodologies for assessing wetland functions and values relative to changes in the upland landscape. EPA is now requiring all states to create a methodology to assess wetlands on a statewide basis in the same way that the state assesses water quality in streams and lakes (see Chapter 2 – Rivers section 2.2.1 and Chapter 3 – Lakes and Ponds section 3.1.2). Water quality assessment includes evaluation of aquatic habitat and water-dependent wildlife habitat as well as hydrology, sediment, and pollutant loading. The process is similar to the analysis of wetland functions and values, and includes evaluation of most factors identified by the U.S. Army Corps of Engineers as secondary impacts. This effort will take several years and significant resources but will provide a way of characterizing and assessing wetlands. The current work underway by the UNH Cooperative Extension to update the "New Hampshire Method" will also help in this process.

Figure 5-9. Forested wetland in Bow. ***Source: NHDES Wetlands Bureau.***

Second, the Legislature should define the extent of unacceptable indirect impacts to wetlands and water bodies. This could be done

in the context of revising legislative language for water quality standards in RSA 485-A to be explicitly consistent with the federal Clean Water Act language on indirect impacts. RSA 482-A, the Wetlands Act, could also be revised to include indirect impact thresholds and protection authority.

Third, the state needs to make an informed and intentional decision regarding the best way to regulate the indirect impacts of development. Recent New Hampshire Supreme Court decisions have demonstrated the limited reach of state wetlands legislation to regulate indirect impacts. The state should work toward a consensus regarding the impacts that are of concern, the manner in which they should be regulated, and at what level: federal, state or local. Indirect impacts are not specific to wetlands; surface waters are also subject to them as development changes the landscape. Implementation of DES's surface water antidegradation policy is one possibility for addressing this. Floodplain development is another area in which indirect impacts can severely impact human life and property and may be an appropriate area to regulate under the state wetlands law.

5.4.2 Increase and Improve Local Involvement

The protection of wetlands and their functions and values is dependent on local involvement, as New Hampshire has no state-required buffer on most wetlands. There is a need for improved local land use planning, inventory of wetlands, and surveillance of activities in and around wetlands. Additional resources should be directed at educating and supporting this vital local role. The goal of this effort should be to produce well-informed local experts who can provide constructive input to regulatory decisions, to develop better local ordinances, and, most critically, to guide individual property owners to the correct course of action. DES should pursue various measures to improve communications with conservation commissions.

References

Ammann, A.P. & Stone, A.L. (1991). *Method for the comparative evaluation of nontidal wetlands in New Hampshire* (NHDES-WRD-1991-3). Concord, N.H.: New Hampshire Department of Environmental Services. Reprinted March 2003, Durham, N.H.: Natural Resources Conservation Service. Available at: ftp://ftp-fc.sc.egov.usda.gov/NH/Ecological_pubs/NH_Method_Part1.pdf.

Carter, V., Bedinger, M. S., Novitzki, R. P., & Wilen, W.O. (1979). Water resources and wetlands. In P. E. Greeson, J. R. Clark, & J. E. Clark (eds.), *Wetland functions and values: The state of our understanding* (pp. 344-376). Minneapolis, Minn.: American Water Resources Association.

Chase, V., Deming, L., & Latawiec, F. (1995). *Buffers for wetlands and surface waters: A guide for municipalities* (rev. ed. 1997). Audubon Society of New Hampshire and New Hampshire Office of State Planning. Available at: http://www.nh.gov/oep/resourcelibrary/documents/buffershandbook.pdf.

Clean Water Network. (2002). *New Hampshire waters*. Retrieved November 7, 2007 from CWN Web site. Available at: http://www.cleanwaternetwork.org/docs/publications/factsheets/states/nh.pdf.

Cook, R.A., Stone, A.J.L., & Ammann, A.P. (1993*). Method for the evaluation and inventory of vegetated tidal marshes in New Hampshire (coastal method)*. Concord, N.H.: The Audubon Society of New Hampshire.

Dahl, T.E. (1990). *Wetlands losses in the United States, 1780's to 1980's*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Online. Available at: http://www.npwrc.usgs.gov/resource/wetlands/wetloss/index.htm#contents.

Golet, F.C., Calhoun, A.J.K., DeRagon, W.R., Lowry, D.J., & Gold, A.J. (1993). *Ecology of red maple swamps in the glaciated Northeast: a community profile* (U.S. Fish and Wildlife Service Biological Report 12). Washington, D.C.: U.S. Department of the Interior. Available at: http://www.nwrc.usgs.gov/techrpt/93-12.pdf.

Madison, S. & Paly, M. (1994). *A world in our backyard: A wetlands educational & stewardship program*. New England Interstate Water Pollution Control Commission. Chapel Hill, N.C.: Environmental Media Center.

National Association of Counties. (2006). *Benefits of wetlands*. Retrieved November 7, 2007 from NACO Web site. Available at: http://www.naco.org/Content/ContentGroups/Programs_and_Projects/Environmental1/Water1/Benefits_of_Wetlands_Brochure_Web_withpagenumbers.pdf.

New Hampshire Department of Environmental Services. (2002). *Wetlands Bureau annual report: FY 2002* (NHDES-WD-03-3).

New Hampshire Department of Environmental Services. (2004). *2004 Section 305(b) and 303(d) consolidated assessment and listing methodology* (NHDES-R-WD-04-5). Prepared by G. Comstock, NHDES Watershed Bureau. Available at: https://www.airquality.nh.gov/WMB/swqa/2004/documents/CALM.pdf.

New Hampshire Department of Environmental Services. (2008). Wetlands Bureau. Unpublished data.

New Hampshire Fish & Game Department. (2006). *New Hampshire wildlife action plan*. Available at: http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.

New Hampshire Office of Energy and Planning. (2006, November). *New Hampshire population projections for state and counties 2010 to 2030*. Available at: http://www.nh.gov/oep/programs/DataCenter/Population/documents/populationforcountiesbyageandsex.pdf.

Novitzki, R.P. (1979). Hydrologic characteristics of Wisconsin's wetlands and their influence on floods, stream flow, and sediment. In P. E. Greeson, J. R. Clark, & J. E. Clark (eds.), *Wetland functions and values: The state of our understanding* (pp. 377-388). Minneapolis, Minn.: American Water Resources Association.

Novitzki, R.P., Smith, R.D., & Fretwell J.D. (1997). *Wetland functions, values, and assessment, in restoration, creation, and recovery of wetlands* (U.S. Geological Survey Water Supply Paper 2425). Retrieved June 27, 2008 from: http://water.usgs.gov/nwsum/WSP2425/functions.html.

Odell, J., Eberhardt, A., Burdick, D., & Ingraham, P. (2006). *Great Bay restoration compendium.* The Nature Conservancy and University of New Hampshire. Durham, N.H.: New Hampshire Estuaries Project. Available at: http://www.nhep.unh.edu/resources/pdf/great_bay_restoration-tnc-06.pdf.

Tiner, R.W. (1984). *Wetlands of the United States: Current status and recent trends*. National Wetlands Inventory, U.S. Fish and Wildlife Service. Available at: http://wetlandsfws.er.usgs.gov/status_trends/national_reports/1983_1984_Status_Report.pdf

Tiner, R.W. (2003). *Correlating enhanced National Wetlands Inventory data with wetland functions for watershed assessments: A rationale for Northeastern U.S. wetlands*. National Wetlands Inventory, U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, Mass.

Tiner, R.W. (2007). *New Hampshire wetlands and waters: Results of the National Wetlands Inventory*. U.S. Fish and Wildlife Service, Northeast Region 5, Hadley, Mass. Available at: http://des.nh.gov/organization/divisions/water/wetlands/documents/wetlands_summary.pdf.

U.S. Army Corps of Engineers New England District. (2007). *Department of the Army Programmatic General Permit, State of New Hampshire* (General Permit No: NAE-2007-461). Available at: http://www.nae.usace.army.mil/reg/NH%20PGP%20-%20Final%20PN%20&%20PGP%20for%20Website.pdf.

U.S. Army Corps of Engineers New England District. (2008). *A tradition of service in New England*. Retrieved July 3, 2008 from USACOE Web site. Available at: http://www.nae.usace.army.mil/missorga/corps.htm.

Wright, T., Tomlinson, J. Schueler, T., Capiella, K., Kitchel, A., & Hirschman, D. (2006). *Article 1 of the wetlands & watersheds article series: Direct and indirect impacts of urbanization on wetland quality.* Prepared for Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency. Ellicott City, Md.: Center for Watershed Protection. Available at: http://www.cwp.org/Resource_Library/Special_Resource_Management/wetlands.htm.